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On the long-term trends of public debt

Implications of the government's Ponzi game and ageing

SUMMARY: This paper sets out to analyse the impact of global ageing on the financeability of states. It covers issues regarding the sustainability of public debt and theories addressing the repayability of debt. It presents the possibilities of a fiscal Ponzi game, which would allow the financing of the debt burden from borrowings and enable succeeding generations to roll over public debt. Sustainability depends greatly on the relationship between interest rates and economic growth, and if the growth rate exceeds the interest rate charged on public debt, the Ponzi game will not only be feasible, but it will also have a Pareto optimal outcome. However, if the growth rate is lower than the interest rate, the Ponzi scheme cannot be run over the long term. The global ageing of the population fundamentally changes the financing environment of countries and government debt. The financing terms of public debt worsen significantly as baby boomers reach retirement age. The soaring old-age dependency ratio exacerbates the relationship between interest and economic growth. The primary balance effects are dramatic. This increases the supply of demography-related government securities, while the demand for government papers diminishes amid declining macro level savings. Over the coming decades, this may give rise to unusual price and quantity problems on a global scale across government paper markets. Grasping the issues of public debt is particularly relevant in the context of current global and domestic debt developments. The ongoing debt crisis is further compounded by demographic tensions. In point of fact, from an intuitive perspective, the countdown to the retirement of baby boomers may well be one of the underlying reasons for the debt crisis, if not for the entire global financial crisis.

KEYWORDS: ageing, public debt, sustainability, Ponzi game
JEL CODES: J11, J14, H63, H68

ON THE SUSTAINABILITY OF PUBLIC DEBT

Firstly, we focus on the sustainability issues of public debt. We proceed to discuss the Ponzi game related to government debt. Finally, with a view to providing more insight into public debt scenarios for the coming years, we present the demographic implications of ageing.

In modern states it is not uncommon that public expenditures exceed revenues, thereby generating deficits. The deficit is typically financed by borrowings (bond issues), which leads to the accumulation of government debt.[1]

It may sound surprising, but most core issues of government debt started to crop up in economic thinking centuries ago. Nonetheless, economists are yet to come up with a common position in respect of the role and size of public debt. In one area, however, there is general consensus. Namely the area of sustainability. Be its debt ratio high or low, a country should strive to avoid putting the debt-to-GDP ratio on a growth path by any means, as this could set off a debt spiral and eventually lead to national bankruptcy or forced adjustment. Therefore, before turning to demographic aspects, we need to address the issue of sustainability.

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On a global scale debt ratios could be very different; in fact, they show a rather diverse picture in terms of chronology as well. During the previous centuries only war-ridden periods produced markedly high debt ratios. For example, in the wake of the Napoleonic Wars the debt ratio of the United Kingdom reached 260 percent,[2] and rose to a similar level after World War II as well.[3] In times of peace debt-to-GDP ratios tended to be much lower; however, they demonstrated steady growth following World War II. Previously, only periods of war saw debt ratios similar in magnitude to those observed following the current crisis.

The basic starting point in defining the sustainability of the debt ratio is the size of deficit or primary balance under which the public debt to GDP ratio can be sustained. According to the simplest correlation,[4]

$$(1) \qquad b_1 = b_0 \times \frac{1}{1+y_1} + d_1$$

where d is the deficit ratio of the central government, b is the debt ratio, while y indicates the nominal GDP growth rate.

The formula clearly demonstrates the relationship between the evolution of the public debt ratio and the growth rate, as well as the deficit ratio. Based on the criterion of sustainable debt ratio () it is simple to arrive at a correlated equilibrium:[5]

$$(2) \qquad d_1 = b_0 \times \frac{y_1}{1+y_1}$$

Breaking down the fiscal balance into primary balance and interest expenditures yields the following correlation:

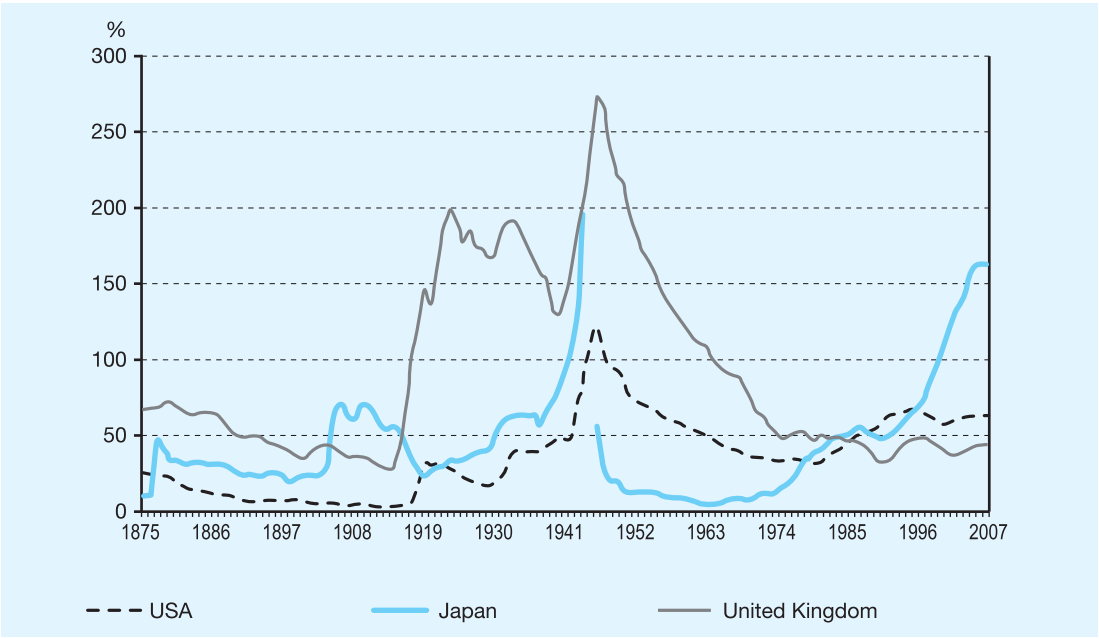
$$(3) \qquad b_1 = b_0 \times \frac{1+i_1}{1+y_1} - pb_1$$

where i is the nominal interest rate charged on debt, which establishes a relationship between total outstanding debt as of the beginning of the year and intra-year interest payments, while pb indicates the GDP-proportionate primary balance.

Chart 1

DEVELOPMENTS IN GOVERNMENT DEBT-TO-GDP RATIOS SINCE 1875

(%)



Source: Cottarelli, 2009

The sustainability criterion is calculated as follows:

$$pb_1 = b_0 \times \frac{i_1 - y_1}{1 + y_1} \quad (4)$$

These correlations may be expressed with real variables as well:

$$b_1 = b_0 \times \frac{1 + r_1}{1 + g_1} - pb_1 \quad (5)$$

where r is the real interest rate charged on debt, while g designates the real growth rate

The correlated equilibrium, in turn, can be described as:

$$pb_1 = b_0 \times \frac{r_1 - g_1}{1 + g_1} \quad (6)$$

This formula may be recognised as $pb=b \times(r–g)$, albeit in a slightly inaccurate form

Accordingly, changes in the initial public debt ratio determine the evolution of the debt ratio. It is clear from this arithmetic that even a relatively minor change in the relationship between the interest rate and growth or in the primary expenditures could easily instigate a shift to a substantially higher debt ratio (Feldstein, 2004). While it is possible to sustain high public debt ratios as well, in these circumstances the sustainability of the country as a whole can be jeopardised even by the slightest changes in interest rate and growth conditions (see Erdős, 2000).

Thus, the main conclusions of the sustainability equations are the following:

- the relationship between (real) interest rates and (real) growth is important,
- the initial value of the debt ratio is a fundamental determinant: a high level of initial debt amplifies the effects of the correlations between real interest and real growth,
- since interest rates and growth tend to fluctuate – in response to not only internal, but also to external effects – a path which earlier appeared sustainable could suddenly become unsustainable,
- this latter effect is all the more pronounced with a high initial debt ratio level.

The relationship between interest rates and growth deserves mention in its own right. When modelling debt paths, it is frequently assumed – based on the experiences of certain countries – that the rate of economic growth exceeds the real interest rate[6], which almost automatically suggests that the specific country is likely to "outgrow" its national debt and avoid a debt crisis. However, the general economic situation is far from being this clear-cut.

REAL INTEREST, ECONOMIC GROWTH AND THE PONZI GAME – DOES DEBT HAVE TO BE REPAID?

What does the theory suggest?

In the standard neoclassical growth model interest (r) is the marginal product of capital, whereas economic growth (g) depends on population growth and technical advancement. Whether the economy has reached a steady state of dynamic efficiency depends on the relationship of these two factors (r and g). All this will have an impact on the possible roles of government spending and public debt. If $r > g$, then the economy has reached dynamic efficiency in the sense that there is no room for a Pareto improvement. In this scenario the condition for future consumption growth is a current increase in the saving rate, which, in turn, boosts investment projects. All this, however, assumes a decline in current consumption. In a situation like this, the economy has insufficient capital to achieve the steady state consistent with the golden rule[7] of capital accumulation.[8] Under these circumstances, the overspending of the government and the crowding out effect of public debt slacken growth and, accordingly, efficiency is not improved in the Pareto sense.

In contrast, if $r < g$, then, according to standard growth models, the economy failed to achieve dynamic efficiency as it has overaccumu-

lated capital.[9] This scenario allows for a Pareto improvement, and the deceleration of capital accumulation may potentially increase both current and future consumption (see Mankiw – Elmendorf, 1998; Cahuc, 2009–2010).[10]

What happens to debt developments, then, when $r < g$? In this case, a Pareto improvement is theoretically achievable. This also suggests that the efficiency of the economy may be improved by a Ponzi scheme run by the government.[11]

What is the government's Ponzi game? – On the deferability of taxation

According to the theory of the influential economist, *Minsky*, the Ponzi game is a debt financing method whereby payments on principal and interest are regularly made from new loans rather than from the profits realised from the investment which the original loan was intended to finance.[12] This implies that loans are never really paid back; the repayment of debt and interests can be deferred interminably. Government debt is particularly interesting from this perspective, as the fact that it involves succeeding generations makes the situation more intricate. In this regard, the question is whether the state can permanently finance its spending without entailing additional tax payments in the future. In other words, can it finance its current spending in such a way that it does not have to be offset by future tax payments, i.e. it does not have to pay either interest or principal from tax payments. If so, then debt and the debt burden can be rolled over to the next generation and the Ponzi scheme can be run. Since generations follow one another, each generation can pass debt payment on to the next generation.

Ricardian equivalence (RE) is an intriguing approach that is also worth mentioning.[13] According to this approach, economic agents assume that the current fiscal deficit translates into future taxes. It may be argued, however, that the state will never really have to repay its debt if it can finance it by borrowings and roll it over through refinancing. For example, if its tax reductions result in fiscal deficit, it can postpone its future debt burden by rolling it over to successive generations ad infinitum.

According to *Mankiw – Elmendorf*, Ricardian equivalence could hold true even if governments never actually pay back their debt. Indeed, in terms of debt financing, they distinguish between two scenarios:

- in the first case, they still pay the interest charged on the debt by offsetting it with increased tax burdens (i.e. with primary revenues),
- in the other case, however, even the interest on debt is financed from borrowings.

In the latter instance, they even the interest is paid from new loans. The authors call this the "real" Ponzi scheme.[14] This is the pilot scheme where old investors are paid from the money of new investors. If the government runs this scheme, its debt will be increased by interest and the initial tax cut will not entail any future tax burden increase. This situation does not imply Ricardian equivalence. Maturing debt is refinanced and the interest is paid from new loans.

We will now explore how the Ponzi game relates to sustainability issues.

The possibilities and effects of a government's Ponzi game

It is an important issue,

- whether debt can be rolled over ad infinitum, and whether the Ponzi game can be played indefinitely,
- what happens if $r>g$ and r is lower than the g growth rate.

On the government's rational Ponzi game

Based on the above we can conclude that, according to theoretical models, debt can be rolled over interminably, i.e. when the interest rate is lower than the growth rate, i.e. *(g > r)*, it is possible to run a Ponzi game. This is what is known as an economically rational Ponzi game run by the government. In this situation the state can issue and roll over debt indefinitely, without having to repay the debt (i.e. the principal) or pay the relevant interest.[15] This implies that debt can be increased without increasing the debt burden. According to theoretical models, at this point the economy is in a state of dynamic inefficiency and overaccumulation. Saving can be reduced by increasing debt. In the absence of a crowding out effect a Pareto improvement can be achieved. In this case debt is increased by *rdB*; however, based on (5) the debt ratio converges to zero[16] (Blanchard – Weil, 2002; Wigger, 2007, p. 9).

The question is whether the fiscal Ponzi game can be really played forever under this scenario? What do the developers of the model (BEM: Ball – Elmendorf – Mankiw, 1995) think about it? It is worth giving a detailed presentation of their important research result. When they examined the relationship of r and g over the long term (for the period of 1871 – 1992),[17] they found that on average, $1+r/1+g$ was smaller than 1 throughout the period as a whole (and in several sub-periods as well) and accordingly, the Ponzi scheme was clearly successful on average by historical standards. While the probability of the game's success somewhat depends on the specificities of the historical periods, the situation is unambiguous in the period following the Second World War, at least in terms of the *(r–g)* value and volatility.

Ball – Elmendorf – Mankiw distinguish the Ponzi scheme from the Ponzi gamble. A Ponzi scheme can be run forever; the government issues a transfer to one generation when it is young and subsequently does not levy additional taxes on any generation on this account. By contrast, the Ponzi gamble is a Ponzi scheme with an escape clause. Namely, if the debt becomes too large, taxes are levied to reduce it after all. A Ponzi gamble succeeds if this never happens, i.e. taxes are never raised due to a current increase in expenditures, while it fails if taxes must be ultimately raised.

The authors claim that, even under a successful Ponzi gamble, an economic policy based on public debt accumulation reflects insufficiently prudent conduct. They emphasise that the *government is nevertheless involved in a gamble*, because there is always a chance, albeit small, that the Ponzi game of its making will fail. Eventually, future generations will have to foot the bill in the form of higher taxes for the lavish spending of past generations.[18] Another important conclusion of the authors is that a Ponzi gamble is much riskier from an ex ante perspective than it is viewed ex post. *Abel* (1992) examined expected (ex ante) changes in public debt ratio in more detail, providing further insight into the debate on the rationality of the Ponzi game. The author set out to demonstrate that in an uncertain world, future developments in economic growth are also shrouded in uncertainty. Under these circumstances, even when $g > r$ holds true there is a possibility that the *expected* debt ratio is set on a growth path *(see Table 1)*.

What causes the low interest rate levels?

We have demonstrated above that the USA saw interest levels below the growth rate over a long-term historical period, which rendered the Ponzi game feasible even by historical standards. However, this is far from the case with the general economic situation. OLG models typically pertain to closed economies. On a global level, "such a free lunch is not possible", claim *Fischer* and *Easterly* (1990).Turning to open economies, however, we can find numer-

Table 1

A GROWING DEBT-TO-GDP RATIO WITH THE INTEREST RATE BELOW THE GROWTH RATE

Period	1	2	3
Debpt	100	104,7	109,62
			360 (25%)
		600 (50%)	
			960 (25%)
GDP	100		
			960 (25%)
		1600 (50%)	
			2560 (25%)
Expected GDP	1000	1100	1210
			0,3045 (25%)
		0,1745 (50%)	
			0,1142 (25%)
	0,10		
			0,1142 (25%)
		0,0654 (50%)	
			0,0428 (25%)
Expected debt/GDP	**0,1000**	**0,1200**	**0,1439**

assumption: r = 4.7%; GDP will randomly be one of the 2 specified values; expected GDP growth: 10%. growth rate deviation can be +6/–4% due to the presence of uncertainty

Source: Abel, 1992, p. 13

ous special factors both in the case of large and small economies, which should be considered in a globalised world economy with liberalised capital flow. As regards the USA, we cannot overlook an important specificity, namely, that its domestic currency serves as a reserve currency for other countries. Consequently, such excess demand for its currency exerts downward pressure on interest rates.[19]

It may happen even in fast-growing economies that growth rates are higher than real interest rates; at the same time, however, there are important counter-forces at work in the market, striving to eliminate this difference. What happens if the growth rate exceeds the interest level? Households, corporations and the government alike take up loans, and since the interest rate charged on the loan is lower than the growth rate of the economy, a surplus will remain even after the interest is paid off (free lunch).[20] That encourages all economic agents to take up more loans. However, increased borrowings also increase the debt level, which drives up real interest rates and reduces economic growth.[21]

If consumers prefer current rather than future consumption, market forces will push interest rates above the growth rate, thus lenders must be compensated for relinquishing their current consumption. "If a rapidly growing economy attempts to exploit the apparently favourable debt dynamics by borrowing excessively, the growth rate will eventually fall below the real interest rate", say Fischer and Easterly.

Accordingly, over a longer time horizon, favourable interest rates and growth dynamics tend to be the exception, rather than the rule. "A prudent assumption on which to base fiscal policy is that the real interest rate will exceed

Table 2

INTEREST RATE – GROWTH DIFFERENTIAL

(geometric averages over the period)

	Nominal interest rate			Interest rate – growth differential	
	Nominal GDP-growth	Effektive*	long-term government bond yield**	Effektive*	long-term government bond yield**
Germany (1992–2008)	2,9	5,7	5,1	2,8	2,2
Ireland (1991–2008)	9,3	5,5	5,8	–3,8	–3,5
Greece (1992–2008)	9,1	8,7	9,6	–0,5	0,4
Spain (1995–2008)	7,1	5,8	5,4	–1,3	–1,8
France (1991–2008)	3,6	5,9	5,5	2,3	1,9
Italy (1991–2008)	4,6	7,5	7,0	2,9	2,4
the Netherlands (1991–2008)	5,1	6,4	5,4	1,3	0,3
Austria (1991–2008)	4,1	5,5	5,4	1,4	1,3
Portugal (1991–2008)	6,5	8,0	6,9	1,5	0,4
Finland (1991–2008)	4,1	6,7	6,2	2,6	2,1
Sweden (1995–2008)	4,6	5,3	5,3	0,7	0,7
Inited Kingdom (1991–2008)	5,3	6,8	6,2	1,5	0,9
USA (1991–2008)	5,2	5,9	5,6	0,7	0,3
Japan (1991–2008)	0,8	2,9	2,5	2,2	1,7
Canada (1991–2008)	4,9	8,7	6,2	3,8	1,3
Average	**5,2**	**6,4**	**5,9**	**1,2**	**0,7**
Hungary (1999–2009)	*8,7*	*8,0*	*7,8*	*–0,7*	*–0,8*

*Interest paid in period t on debt outstanding at the end of year *t*–1.
**10-year benchmark government bond yield or closest bond yield available

Source: Escolano, J. (2010) p. 9 and own calculations based on data released by the Government Debt Management Agency, the CSO and the MNB

the real growth rate over the long term" (Macklem, 1994/5, pp. 4–15).

Indeed, the latest developments support these arguments *(see Table 2)*. In the last two decades, interest rate levels below the growth rate have not been a typical phenomenon on a global level. The Ponzi game ceased to be feasible even in the USA.

At the same time, however, *Duronelly* (2011) observes Ponzi financing in China in the 2000s.

With a view to defining the dynamic steady state of the economy, a so-called modified golden rule has been laid down (Escolano, IMF, 2010, p. 9).

(7) $\lambda > 0$,

where $\lambda = i - y / 1 + y$

This means that theoretically, over the long term the real/nominal interest rate exceeds the real growth rate.[22] This is known as the No-Ponzi game condition. The modified golden rule has practical significance as well. This rule has been observed in most developed countries over the past two decades. Based on the IMF's study, it is worth using l =1 per cent in practical calculations.

However, it is also important to examine which influences may affect individual countries in a way that would result in a violation of the golden rule, putting the countries concerned in a position conducive to the sustainability of public debt.

Firstly, we discuss the case where a closed economy transforms into an *open economy model*. In such cases the capital flow effects can

be tracked by examining individual countries. Based on this exercise, the following factors may point to a favourable growth–interest rate structure:

- The reserve currency role may be relevant for more developed countries; the reserve currency means capital inflow and additional demand, acting as a safe haven (e.g. the USA, euro) (Feldstein, 2004). A positive externality of the reserve currency role is that it makes the servicing of public debt cheaper.
- Peripheral countries of developed economies: interest rate convergence is the positive external effect of the euro area on the interest rate level, which implies additional demand for public debt service.[23]
- Foreign capital inflows may have a positive effect in developing countries; as long as the inflow lasts, it reduces the domestic interest rate level and accelerates growth (Mackellar, 1999), thereby creating favourable conditions for servicing government debt. However, as soon as the trend reverses, contrasting developments take hold.

In the countries where they exist, the above circumstances support the sustainability of the debt path, thus the public debt problem appears to be more favourable. The question is, what kind of changes can possibly affect these processes, and what kind of shifts will be thereby generated along the debt path. If investors' confidence is shaken (calling into question the success of the Ponzi game), the ensuing increase in the interest rate level (and the deceleration of growth) may abruptly deteriorate the debt path.

In certain countries *domestic developments* may also give rise to interest rates below the growth rate. This depends on whether the specific country offers a broad range of securities and investment options. If a wide variety of securities is available in a country, the debt securities of the government are not likely to be particularly attractive, and they will not become popular enough to ensure that the government can in all certainty roll over (refinance) its debt. However, it is possible to have a set of criteria and a securities market environment in place where conditions support the refinancing of public debt, the most important of which are as follows.

- The range of available securities is not wide enough, government debt and government papers may become attractive for investors; so much so, that the yield on government securities drops particularly low relative, for example, to the average return on capital. In these circumstances investors prefer to hold government securities in their portfolios despite the low yields, which allows for the rollover (regular refinancing) of debt (Abel, p. 15).
- When investors' risk aversion is particularly high, market atmosphere may become conducive to the sale of government papers even though a broad range of investment instruments is available. In such cases investors may be willing to pay rather high premia in order to hold safe government securities. While the latter scenario may relate to circumstances dictated by economic policy, it also conceals numerous demographic conditions. Indeed, since risk appetite depends to a large extent on age, an increase in the ratio of the elderly population will have an impact on the longer-term trend of risk aversion, and hence, the debt financing of the country. We will address the demographic background of public debt servicing in more detail below.
- Investors will even be inclined to buy bonds close to the junk category if the expected change in the specific paper's rating may reward them with a higher yield than the rate of return *(r)*. In this context

$$(p_{t+1} / p_t)^3 r_t,$$

where p is the paper's expected rating and the left side is the expected rating change.

This is also the basis of bubble formation (see Obstfeld – Rogoff, 1996). This also helps explain why investors find the low-yield, long-term government bonds of developed markets appealing. Indeed, as long as there is demand for these bonds, long-term interest rates decline and the rating of the paper increases. Consequently, as long as the long-term interest rate level declines and the paper's rating increases, the paper has high and increasing yield levels. Demand may be sustained by several factors, such as its character as a safe haven currency and the expected yield on the paper itself. The process may last until the short-term interest rate increase commences or until the long-term interest rate drops so low that an increasing number of investors expect a reversal of the trends, namely, the recovery of long-term interest rates.

The Minsky-type borrowers, i.e. those unable to pay either the interest on the debt or its principal, will take up a new loan to cover this. The fundamental interest of these borrowers (i.e. the bond issuers) is to see the value of this instrument (bond) climb continuously, because they cannot refinance their debt in any other way. The bursting of the bubbles, in turn, demonstrates that the wealth (prosperity) supported by the overspending of economic agents is nothing but a fake bubble-driven wealth ("Nouriel Roubini is a Ponzi". ft.com., 12 March 2009). This is how Ponzi finance and bubble formation are interrelated. Declining interest rates may lead to the unusual structure in which the interest rate level is lower than the growth rate. This encourages the indebtedness of states and conceals the fact that amid higher interest rate levels and slower growth they would not be able to service their debt.

This demonstrates that states can run a fiscal Ponzi scheme for a relatively long time; however, the risks involved are rather high. The favourable increases in the interest rate could easily reverse, at which point public debt becomes suddenly unsustainable. Bubble formation is a possibility, but bubbles burst sooner or later, making it clear that there is no such thing as a "free lunch" forever.

Is the Ponzi game feasible amid increasing debt ratios? Visible Ponzi finance

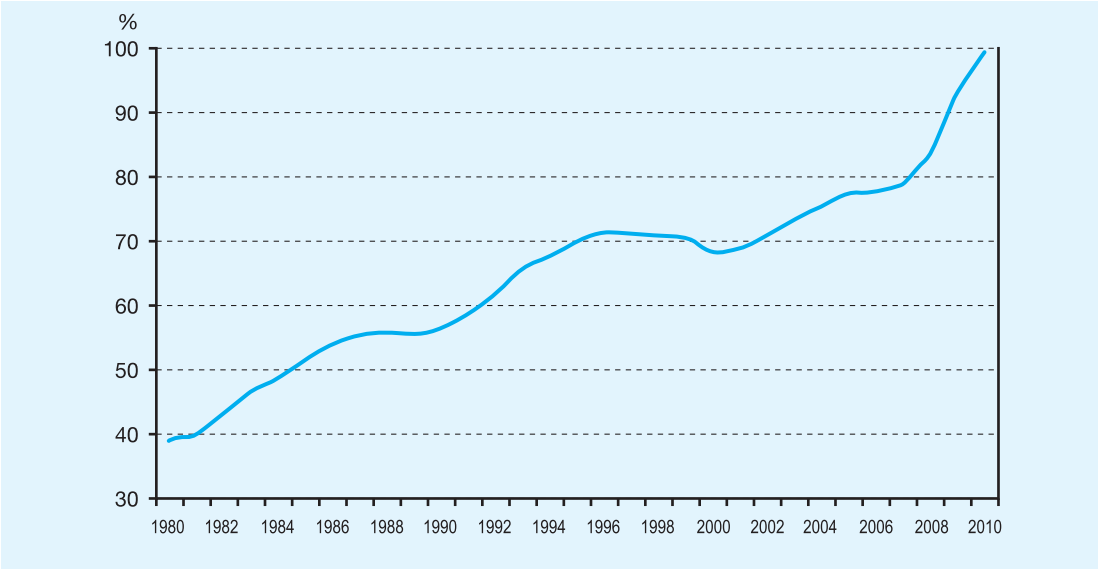
If r is bigger than g, the debt level grows faster than the economy, therefore – in theory – playing a Ponzi game is not possible. This is the previously shown No-Ponzi game condition.[24] In this context, the growing debt ratio will some day lead to a future debt service that is necessarily higher than the total savings. The young generation will not be able to buy all government bonds issued, and the government will not be able to pay interest and principal to the elderly of the time. The current old generation was already aware of this in their youth, thus they did not buy government bonds even when they were young. Therefore, the government faces either bankruptcy, or must raise taxes in order to service its debt (see Elmendorf – Mankiw, 1998, Wigger, 2007). In a broad sense, national bankruptcy may take place in several forms, such as the downsizing or refusal of its liabilities, the refusal of debt repayment, money printing and inflation fuelling.[25] In this situation it is not possible to provide additional income to one generation without laying extra burdens on some other generation. This scenario is not Pareto optimal as it hurts the interest of a future generation.[26]

While theoretically this kind of "gamble" cannot be pursued when the debt ratio is on the rise, in practice, governments engaged in this "game" as a matter of course. By 2007, i.e. the period preceding the crisis, the debt-to-GDP ratio of developed G20 Member States nearly doubled from the 40 per cent observed in the early 1980s, and by 2010 they expected a debt ratio close to 100 per cent.[27] During the years of the crisis, deterioration was particularly severe in Japan and the Anglo-Saxon countries *(see Chart 2)*.

Chart 2

DEBT-TO-GDP RATIO OF DEVELOPED G20 MEMBER STATES

(%)



Source: IMF, 2009, p. 24.

As we have mentioned, several factors result in the fact that economic participants are willing to buy the bonds of governments involved in such schemes. However, as we have demonstrated, this yields dubious results over the long term for those purchasing the securities; either their taxes will be raised or public services will be curbed, or their investment will be written off.

The extremely high debt levels currently observed in developed countries are only comparable to those experienced in times of wars and during the Great Crisis. The question arises whether developed countries are threatened by a real debt crisis, in other words, whether they will remain capable of financing and refinancing their current debts in the future. After the extremely high "wartime" debt levels both the USA and Great Britain saw a sharp decline in debt ratios, which confirmed that the world powers succeeded in "outgrowing" their debts after periods of crisis. The debt-to-GDP ratio of the USA following the Second World War reached levels close to 130 per cent, which then plunged to around 35 per cent before once again embarking on a steep rise from the 1980s.

Let us examine what kind of conditions will prevail over the long term on a global level in terms of debt financing, with special consideration to demographic processes. We will examine what kind of demographic effects will influence debt financing over the coming decades, and review the extent to which these trends can be expected to contribute to – based on historic observations – the reduction of existing, markedly high debt levels.

DEMOGRAPHY AND PUBLIC DEBT

In the presentation of demographic effects, our starting point is the life-cycle model (see Mosolygó, 2009 for more detail). According to the life-cycle model, the saving behaviour of individuals changes throughout their lives. Typically, the younger generation tends to get

indebted; the active middle-aged age group is the generation that accumulates substantial savings, while the older generation is the age group that typically depletes the accumulated savings after retirement.

First of all, the question is: who are the buyers of government securities? According to macroeconomic models which take stock of demographic processes, in the models of generations living together ("overlapping generations", OLG)[28], government papers are bought by active individuals (i.e. those working), for the purpose of building up pension reserves. Government securities are an alternative to shares and other investment instruments. The return on government securities is generally considered "risk-free"; therefore, government security yields are lower than those on risky equity investments. The lower yield reflects the lower level of risk attached to government papers, which stems from the fact that the government's risk of default is smaller than that of companies, while government bond yields are less volatile than equity yields. Consequently, risk-averse investors tend to buy government papers, while those with a higher risk appetite buy shares. Therefore, we can also break down the group of active individuals by age. Younger people are more inclined to buy shares, while the older individuals of the active group prefer to buy government securities. The portfolio structure of life-cycle savings changes according to age; as investors grow older, the share of government papers increases in their portfolio.[29] Therefore, changes in the growth rate of the population and hence, the ageing process, have an impact on the financing capacity of government securities. Indeed, if the proportion of active agents – including that of the elderly – changes, demand for government securities, with all other things being equal, will change by virtue of demographic reasons alone.

The impact of baby boomers – an OLG model

In our simple OLG model of a closed economy, three generations live together: the young and active, the middle-aged and active and the elderly pensioner. The model disregards children. Active agents work and save. Young actives account for a negligible part of savings, setting aside 1 per cent of their income; middle-aged individuals are the main savers with savings of 9 per cent of their income. For the purpose of this exercise, of all components of the portfolio, we will concentrate on bonds only and assume that all savings are invested in bonds. Economic growth is dependent on the active population; the growth effects of capital and technical advancement are disregarded. There is no inflation; debt, economic growth and savings are expressed in real terms. The length of each period is 20 years; therefore, the reviewed 5 periods cover the developments of 100 years. The analysis is also extended to the government. For this purpose, its role is limited to collecting taxes from the active agents and paying pensions to the elderly generation.

Below we set out to model a demographic scenario which took place in the majority of developed countries (including the Central and Eastern European region) following World War II, also referred to as the 'baby boom'. The number of births skyrocketed after World War II, and started to fall off sharply from the late 1960s.[30] This demographic tidal wave then washed over the second half of the 20th century and the beginning of the 21st century. The 1st period of our model is characterised by a permanent population and a permanent population structure. The number of births increases in the 2nd period and falls sharply in the 3rd period. It is at this point that the birth rate stabilises, albeit at a lower level than before. Consequently, population growth surges over the 2nd period and begins to decline gradually

from the 3rd period. Eventually, the decline bottoms out after the 5th period *(see Table 3)*.

The 4th period brings about a fundamental change in the basic employment situation; this is when the baby boom generation is set to retire. Accordingly, the activity rate falls sharply and the (old age) dependency rate rises. The situation is aggravated by the fact that the size of the young population is much smaller than before, thus the increase in the number of elderly is combined with a decline in the active population. The original employment structure is restored in the 5th period, at least in terms of the dependent/active ratio and the saver/spender ratio *(see Chart 3)*.

Table 3

THE DEMOGRAPHIC IMPACT OF THE BABY BOOM IN A SIMPLE MULTI-GENERATION MODEL

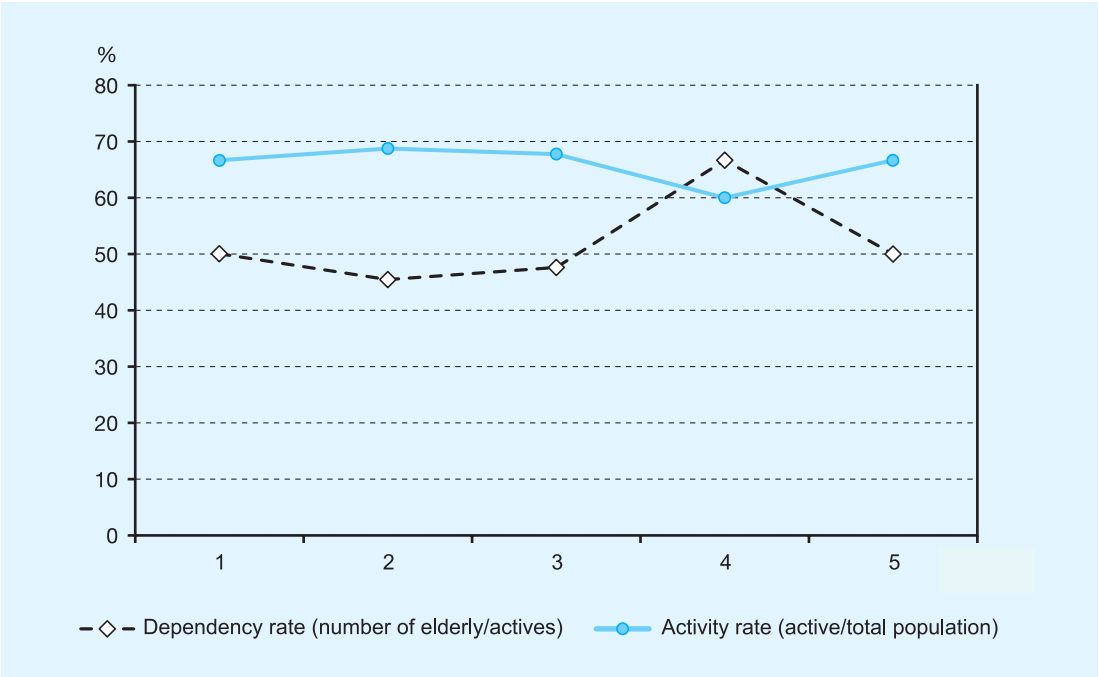
(number of persons, per cent)

Period	1	2	3	4	5
ages 20–39	100	120	90	90	90
ages 40–59	100	100	120	90	90
ages 60–80	100	100	100	120	90
Total population	300	320	310	300	270
Population growth, %	100	107	97	97	90
Dependency rate, %	50	45	48	67	50
Growth of actives, %	100	110	95	86	100
Activity rate, %	67	69	68	60	67

Source: own calculations

Chart 3

CHANGES IN THE DEPENDENCY RATE AND THE ACTIVITY RATE IN THE MODEL



Source: own calculations

The population gets younger in the 2nd period and ages from the 3rd period. The process accelerates in the 4th period, generating a sudden jump in the dependency rate (elderly/active ratio). The BB generation starts to retire and the young generation born during the period of diminished birth rates enters the labour market.

GDP changes in line with the active population (ages 20–59), while savings primarily depend on the number of people in the 40–59 age group. Accordingly, *Chart 4* and *Chart 5* indicate long-term developments in GDP and savings.

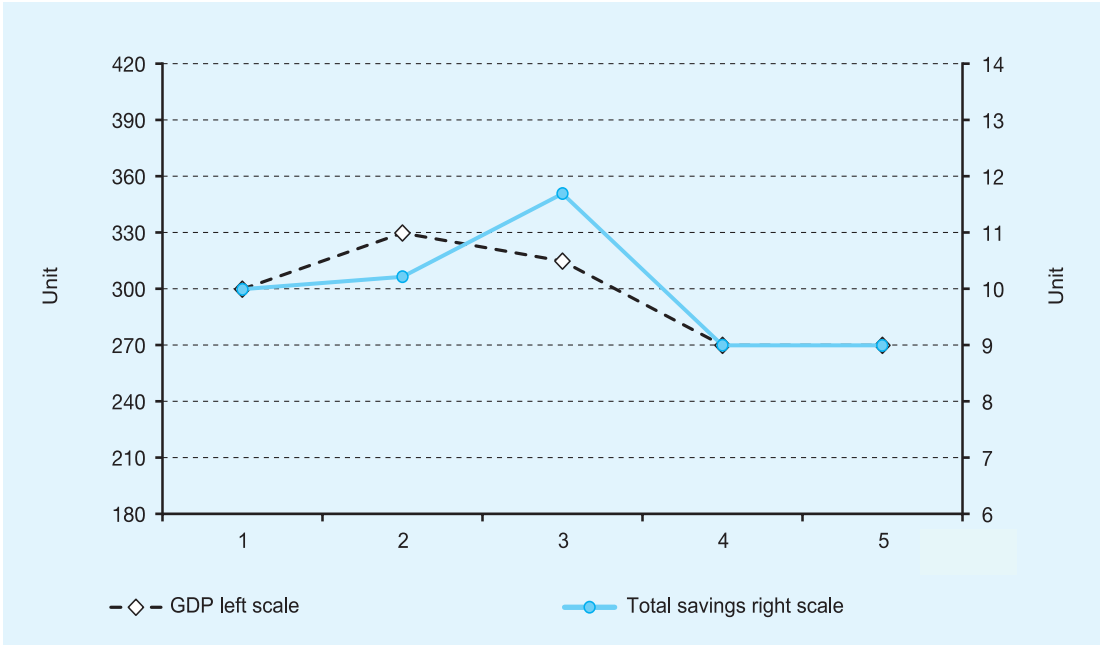
Population structure and saving rates are subject to fluctuations in each demographic period; however, they return to their original state in the 5th period. In contrast, the levels (i.e. population and GDP levels) do not return to their original state after the fluctuations; the population declines and GDP also stabilises at a lower level. The chart demonstrates clearly that once the baby boom generation reaches its saving period (3rd period), it increases its savings, while after its retirement (in the 4th period) both savings and the savings rate fall drastically.

The impact of baby boomers on the debt ratio

Below we explore how demographic shock influences debt trends. The initial debt level is a given, and our first assumption is that the debt level (i.e. real debt) will be maintained; in a constant demographic environment this also implies the maintenance of the debt-to-GDP ratio. On *Table 4*, however, we can track decades of changes in the active population driven by population changes. All this generates changes in GDP, and leads to the fluctuation of the debt ratio even in the context of constant real debt levels. With a growing num-

Chart 4

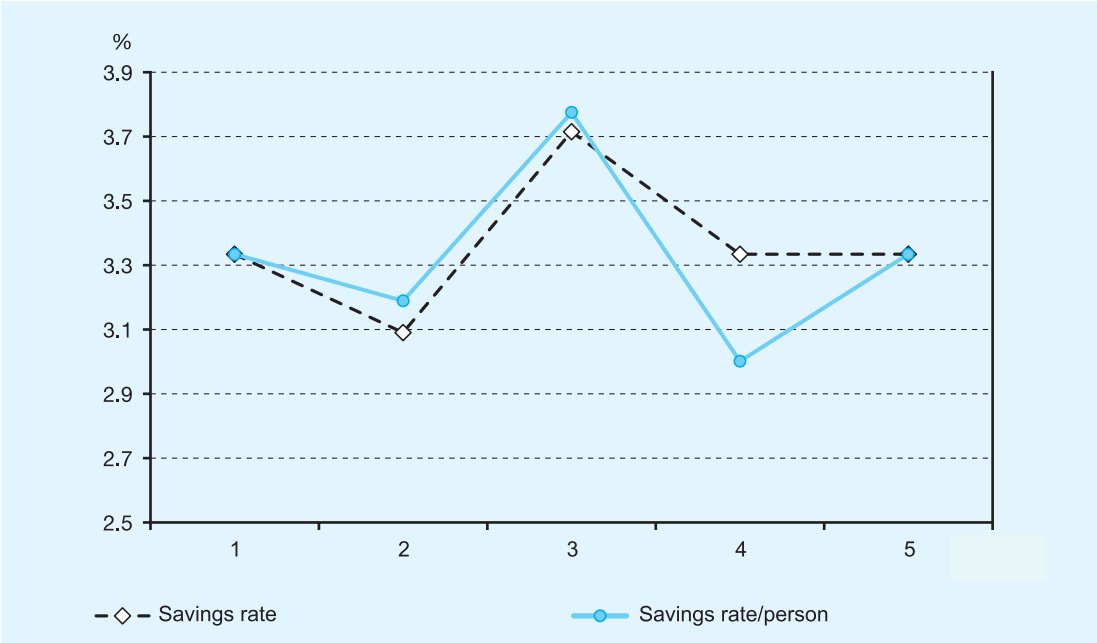
LONG-TERM DEVELOPMENTS IN SAVINGS AND GDP COMPARED TO THE INITIAL PERIOD



Source: own calculations

Chart 5

SAVING RATE DEVELOPMENTS IN THE MODEL



Source: own calculations

Table 4

BABY BOOM AND DEBT/GDP RATIO IN THE OLG MODEL

Period	1	2	3	4	5
GDP	300	330	315	270	270
Debt/real	150	150	150	150	150
Debt/GDP, %	0	45	48	56	56
Debt/person	0,50	0,47	0,48	0,50	0,56
Debt/active	0,75	0,68	0,71	0,83	0,83
Debt level stabilising the debt ratio	150	165	158	135	135

Source: own calculations

ber of active individuals and in an environment of economic growth, the debt ratio initially falls, then later, as the ageing process advances, it begins gradually to climb. Therefore the baby boom initially improves the debt position, but markedly aggravates it as the generation reaches retirement. Despite the constant debt level, the initial 50 per cent debt ratio rises to 56 per cent. This suggests that a decline in the population requires more effort; in order to maintain the level of the debt ratio, the real debt level must be reduced (in the 4th and 5th periods the initial debt ratio can be achieved only with 135 units of debt instead of 150 units).

Let us now examine the dynamics of supply and demand in the government securities markets during the different periods. The supply of government securities is the government debt itself; in turn, the demand for government securities is expressed by the bond portfolio within the savings of households (although these sizes are obviously identical ex post,[31]

this does not necessarily hold true ex ante). Demographic structure and propensity to save together determine the capacity for security financing, including the capacity for government security financing. Savings are boosted when the baby boom generation reaches middle-age and develops a bigger propensity to save and purchase government papers. Changes in life-cycle preferences and the demographic situation lead to changes in saving, and hence, the demand for bonds.

We assume that in the 1st period public finances are in equilibrium and the government strives to maintain the level of real debt. As *Chart 6* indicates, the financing position in respect of public debt is different in each period.

The situation is favourable in the 1st, 2nd, 3rd and 5th periods, when the demand for government bonds is adequate thanks to the sufficient level of savings accumulated by the population; moreover, these savings are held by the active middle-aged age group (risk avoiders). The primary balance is either in a stable equilibrium, or shows a surplus. The situation is completely different in the 4th period when the BB generation retires. The financing position of public debt deteriorates drastically, and a large gap opens up between the supply of government bonds (primary deficit) and the demand thereof (bond savings), at least when taking account of the changes in demographic structure only.

Obviously, this market situation will have an impact on the interest level. It exerts downward pressure on interest rates throughout the 1st, 2nd, 3rd and 5th periods and drives up interest rates in the critical 4th period. In any case, based on the above and with all other things being equal, the 3rd and 4th periods are characterised by the following correlations:

$$r_4 > r_3 \text{ and}$$
$$g_4 < g_3$$

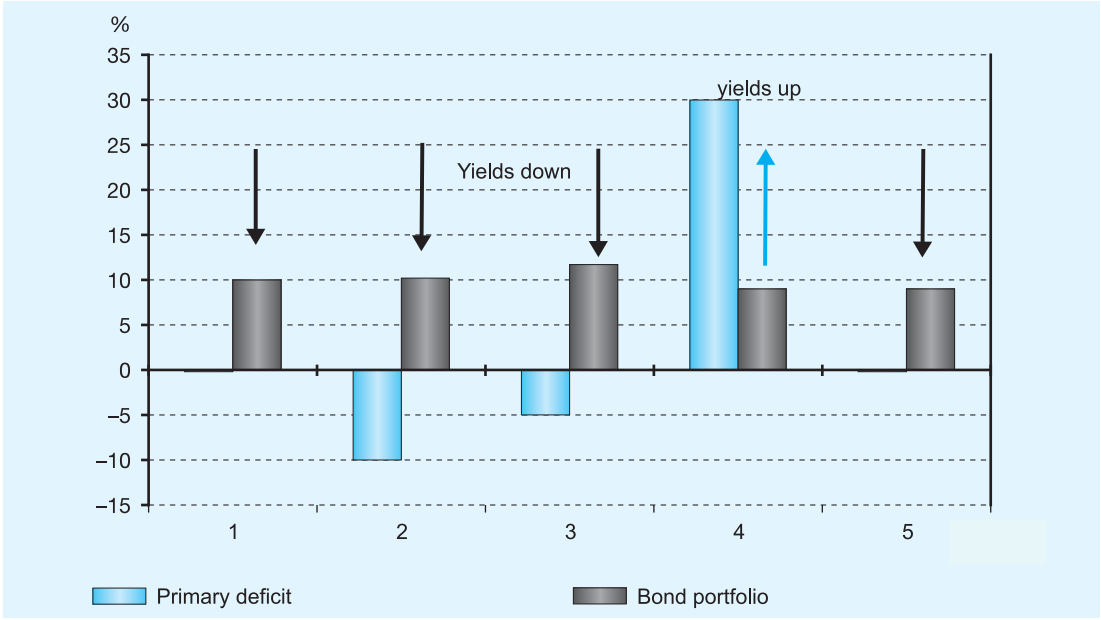
gives the

$$r_3 - g_3 < r_4 - g_4$$

Chart 6

BOND MARKET SITUATION BASED ON DEMOGRAPHY

(ex ante assessment)



Source: own calculations

correlation (the indices indicate the specific periods).

Based on (5) and (7) this also means that, upon the retirement of the baby boom generation (4th period), owing to the unfavourable change in the interest–growth dynamics, a substantial amount of primary surplus will be required for the stabilisation of the debt ratio. Moreover, this has to be achieved in the context of worse growth performance relative to the previous periods.

Thus, ageing – when the elderly population drastically increases compared to the size of the active population – gives rise to lower saving levels, lower GDP growth rates and higher interest rates at a time when the primary surplus requirement for the state budget also increases. Another important lesson to be drawn from the model is the fact that, in addition to the dependency rate, the ratio of the middle-aged generation (ages 40–59) to the elderly is also of great importance. It is the responsibility of the saving (middle-aged) generation to finance public debt, more specifically, to ensure the refinancing of public debt. The middle-aged population accomplishes this by purchasing public debt from the elderly. If the next generation has less savings than the previous one, it will have a severe impact on the ability to finance the debt.

In the 1st, 3rd and 5th periods the debt can be financed on favourable terms and, in terms of demand, there is even room for the debt (and the debt ratio) to grow. Obviously, in these circumstances there is no obstacle to debt being rolled over. Both the GDP *(g)* and the interest rate level *(r)* move in a direction that can easily create the conditions for a Ponzi game. Therefore, the 1st, 3rd and 5th periods are highly conducive to the government's Ponzi scheme. Debt can be rolled over and interest can be paid from borrowings.

The situation in the 4th period, however, is entirely different. Demand for bonds declines and the debt financing capacity drops below the debt financing requirement, rendering the refinancing of public debt uncertain.

We have previously assumed that the sustainability of debt is ensured by a constant debt ratio. The change in the demographic situation, however, may necessitate a reduction of the debt ratio. Therefore, when the BB generation retires in the 4th period, the government may be forced to increase the primary surplus, which implies that it actually has to repay a portion of the debt. At this point additional primary fiscal revenues are required to secure not only interest payments, but principal repayment as well. This exerts enormous pressure on the primary balance. In the 4th period the Ponzi game fails; at this point there are no more additional savings to ensure the rollover of debt and to cover interest payments. The debt pilot scheme eventually collapses; it is precisely the change in the demographic situation that renders it impossible to continue.

We will now attempt to examine the effect of ageing on the primary balance.

Ageing and primary balance: prospects

The surge in the number of elderly persons has a dramatic effect on the fiscal position of developed countries. The healthcare, social and pension expenditures of governments continue to grow gradually, substantially and inexorably over the course of the following decades, foreshadowing the escalation of primary deficit. Ageing affects not only developed countries, but nearly the entire world, the only exceptions being India, the Near East and African nations. Based on our multi-generation model, below we forecast the ageing-induced increases in debt in developed countries. We assume that the initial levels of government expenditures and revenues are in equilibrium, accounting for 20 per cent and 40 per cent of GDP, respective-

ly.[32] Expenditures are limited to those related to the elderly. During the periods to follow revenues are in line with GDP (i.e. the active population), while expenditures follow changes in the elderly population.*(see Table 5)*.

Evidently, from the perspective of the debt-to-GDP ratio, the primary balance observed in the 2nd and 3rd periods is favourable; however, it deteriorates substantially over the 4th period. We also attempted to model the impact of old age spending on the debt ratio over the same period. According to the assumption applied in the model, individual countries gradually reach the primary deficit characterising the period of 7 and 13 per cent. In addition, we also used two baseline scenarios in respect of the interest rate spread and the initial debt level: with $r–g=1$ per cent and $r–g=3$ per cent, the initial debt level is 50 per cent in the first scenario (e.g. the CEE region) and 100 per cent in the second scenario (average of G20 Member States in 2010).

As *Charts 7* and *8* clearly indicate, over the next two decades public debt will be subject to robust growth pressures from the ageing side. According to the demographic processes, debt ratios may well double, *ceteris paribus*, during the next 20 years, particularly in rapidly ageing developed countries.

Obviously, with higher initial levels of old age spending the effects can be even more dramatic than indicated in the chart. If the fiscal redistribution ratio modelled in the first version doubled, the impact of ageing would translate into the previously mentioned "wartime" debt ratios *(see Table 6)*.

Accordingly, with all else being equal, the growing number of the elderly will fundamentally change the basic conditions of debt financing over the next few years.

Our model, therefore, clearly demonstrates that the financing terms of public debt will drastically deteriorate as a result of the ageing of the population. In the long run, ageing will lead to a drastic spike in the debt ratio. Our model indicates a surge in the financing requirement amid plummeting financing capacity.

In the previous section we have already referred to the tensions stemming from the decline in savings. Given the expected pressures arising from increased expenditures, these effects are likely to intensify. We may conclude that the market environment for public debt financing will experience a spectacular turnaround compared to the last few decades. Over the coming decades, governments will face volume and price problems on a global scale in the financing of public debt. In view of the described market developments it would not be surprising to see dramatic yield effects as well. Demography-based yield projections (e.g. those released by Barclays Capital in February 2010) forecast long-term US and UK yields of around 10 per cent by as early as 2020.[33] In this regard, it would be a delusion to surmise that, based on the assumption of capi-

Table 5

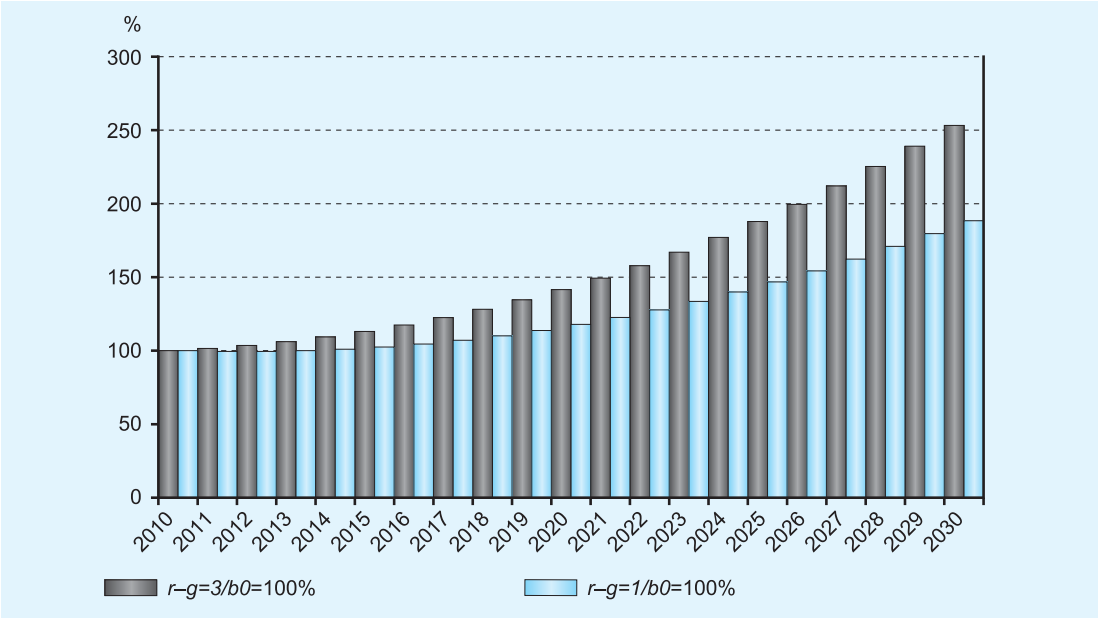
THE IMPACT OF AGEING ON THE PRIMARY BALANCE WITH INITIAL OLD AGE SPENDING OF 20 PER CENT

Period	1	2	3	4	5
Primary expenditure	60	60	60	72	54
Primary revenue	60	66	63	54	54
Primary balance	0	6	3	–18	0
Primary balance/GDP, %	**0**	**2**	**1**	**–7**	**0**

Source: own calculations

Chart 7

THE IMPACT OF AGEING ON THE DEBT RATIO*

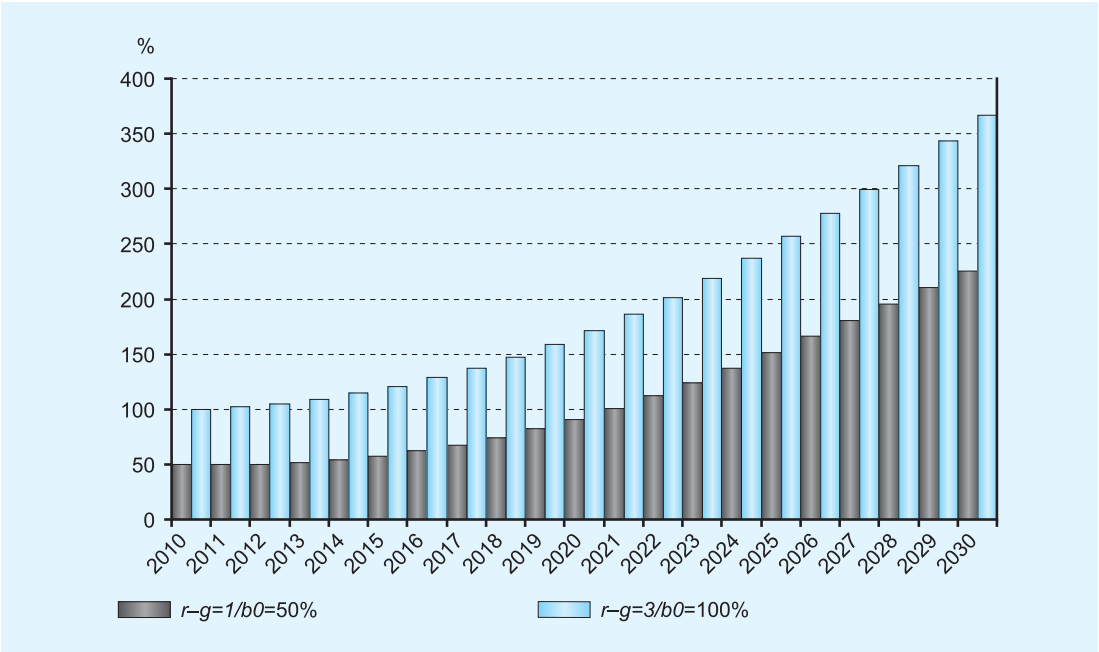


* *Note:* assuming 20% old age spending as a percentage of GDP

Source: own calculations

Chart 8

IMPACT OF AGEING ON THE DEBT RATIO UNDER DIFFERENT SCENARIOS



Note: assuming 40% old age spending

Source: own calculations

Table 6

THE IMPACT OF AGEING ON THE PRIMARY BALANCE WITH INITIAL OLD AGE SPENDING RATIO OF 40 PER CENT

Period	1	2	3	4	5
Primary expenditure	120	120	120	144	108
Primary revenue	120	132	126	108	108
Primary balance	0	12	6	–36	0
Primary balance/GDP, %	0	4	2	–13	0

Source: own calculations

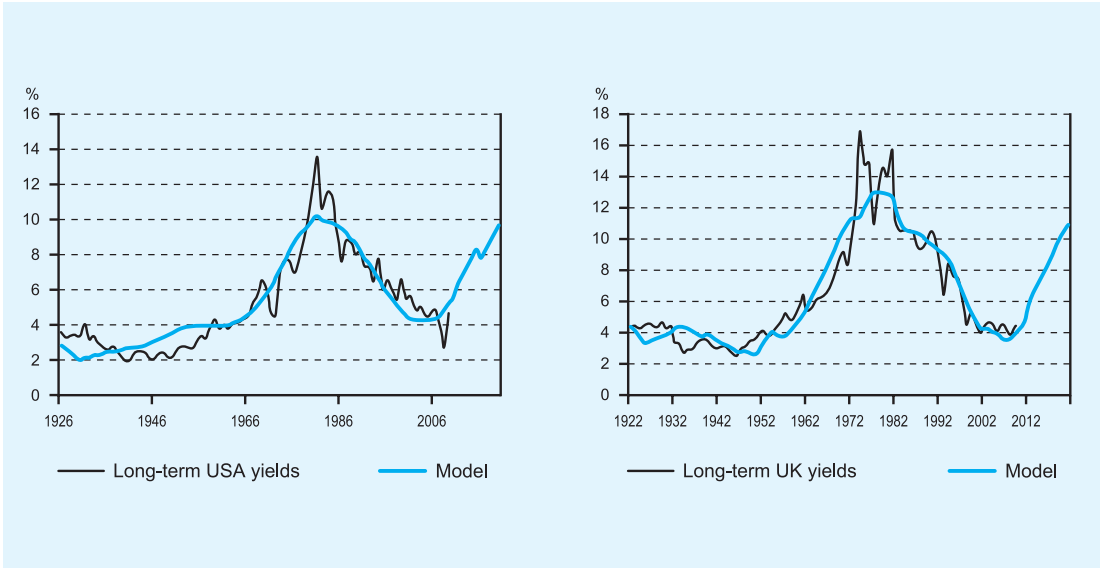
tal flows (i.e. an open economic model) demographic effects may be negligible. The bottom of the demographic wave will reach most developed countries – along with the most important developing countries – almost at the same time. Thus the demography-based decline in savings and low financing capacity are global phenomena, equally affecting open economies without being notably mitigated by the capital inflows to emerging markets[34] *(see Chart 9)*.

The situation may be further aggravated by rising yields and by the fact that higher debt ratios restrain growth. Each element in formula (5) deteriorates and cross effects reinforce each other. This confirms that our presentation of the demographic effects was not in the least exaggerated. Thus each element of the debt formula points to soaring debt: $r–g$ deteriorates while pb is on the rise. This will presumably force governments to introduce radical changes in economic policy. Undoubtedly, the economic policy response to the current crisis was to increase public debt. While this effect represents a shock in itself, it is negligible compared to that arising from the demographic processes over the coming decades *(see Table 7)*.

Economic policies have the possibility to mitigate the demographic effects in a proactive

Chart 9

DEMOGRAPHY-BASED BOND YIELD MODELS



Source: Barclays Capital, 2010

Table 7

NET PRESENT VALUE OF DEFICITS ARISING FROM AGEING AND THE CRISIS

	Crisis (as a percentage of GDP) (1)	Ageing (as a percentage of GDP) (2)	(1)/(1)+(2) (%)
Australia	26	482	5,1
Canada	14	726	1,9
France	21	276	7,1
Germany	14	280	4,9
Italy	28	169	14,2
Japan	28	158	15,1
Korea	14	683	2,0
Mexico	6	261	2,2
Spain	35	652	5,1
Turkey	12	204	5,6
UK	9	335	7,9
USA	34	495	6,4
Advances G20	**28**	**409**	**4,9**

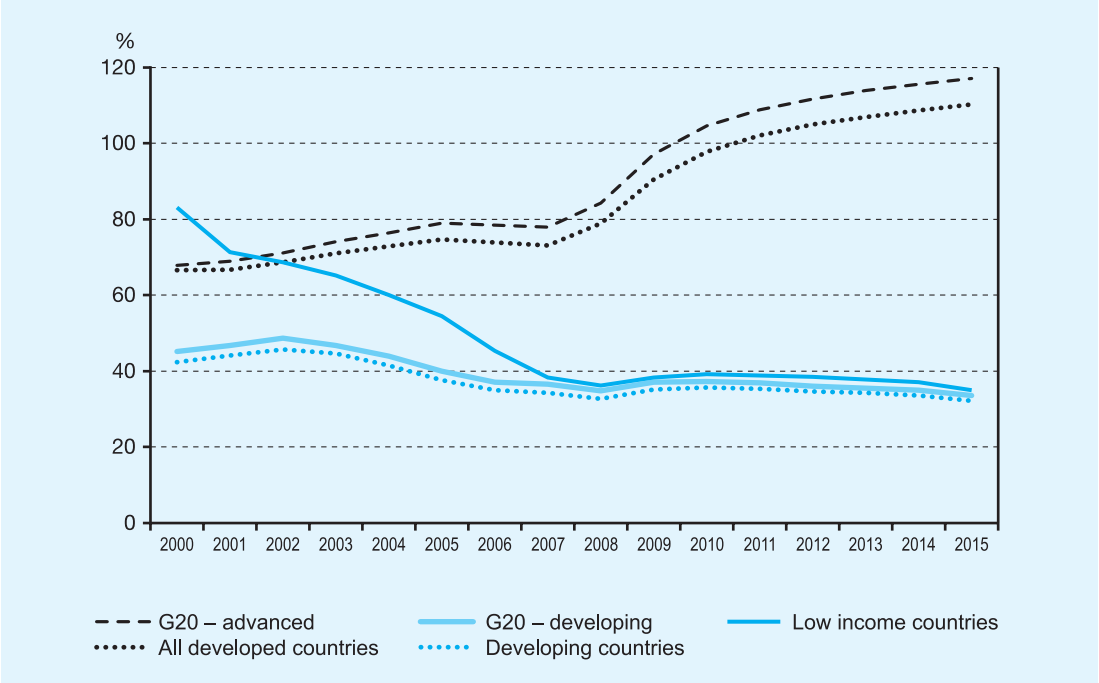
Note: The table presents the estimated effects of the crisis as at the beginning of the crisis; however, the difference in magnitude of the two effects holds true even after taking into account the developments observed since then.

Source: IMF, 2009

Chart 10

CHANGES IN THE DEBT RATIO AND ITS FORECAST

(weighted with GDP at purchasing power parity)



Source: IMF, 2010

manner. This may involve the extension of the activity period on one side, and measures to improve, as soon as possible, the primary balance on the other side.[35]

It is also important to see that stepping into the demographic pothole with a lower debt ratio will make the stabilisation of a country's situation easier: indeed, the increase in $r–g$ has a more moderate impact on countries with lower initial debt ratios. Therefore, as regards the future of debt financing, EM countries fare better than developed countries as their initial debt ratios are only a half of the debt ratios of developed countries. EM countries with high debt ratios (such as Hungary) are exceptions; in these countries the greater vulnerability entailed by the EM position is coupled with a more severe debt financing problem. Even the long-term debt prospects of EM countries are better, partly because of their lower initial debt ratio and partly because they have a slower ageing population compared to developed countries *(see Chart 10)*.

Moreover, the capital market analysis of the ageing processes (see Mosolygó 2009, 2010) raises the question of whether there is a link between the current crisis and the ageing revolution, in other words, the ongoing retirement of the BB generation. Indeed, this process reduces the demand for investment instruments in developed countries, decreases consumption and savings and restrains potential growth. At present it is only a hunch that the current crisis may reflect the acceleration of the ageing process. However, it foreshadows long lasting issues and burdens for the global economy as a whole.

Annex

Assumptions and correlations in our OLG model

(in a closed economy and a two-actor model: households-state)

N_{1t} population aged 20 to 39 (youth) in year t
N_{2t} population aged 40 to 59 (middle aged) in year t
N_{3t} population aged 60 to 80 (elderly) in year t

$Nt = \sum_{i=1}^{3} N_{it}$ total population in year t

$A_t = \frac{N_{1t} + N_{2t}}{N_t}$ activity rate in year t (active/total population)

$F_t = \frac{N_{3t}}{N_{1t} + N_{2t}}$ dependency rate in year t (retired/active)

$n_t = \frac{N_t}{N_{t-1}}$ growth rate of population in year t

$a_t = \frac{N_{1t} + N_{2t}}{N_{1(t-1)} + N_{2(t-1)}}$ growth rate of active population in year t

$g_t = \frac{Y_t}{Y_{t-1}}$ economic growth in year t

$Y_t = 3\frac{N_{1t} + N_{2t}}{2}$ production side in year t (a function of the number of active individuals)

$Y_t = C_{1t} + C_{2t} + C_{3t}$ consumption side in year t (a function of consumption)

M_{1t} youth savings in year t
M_{2t} middle-aged savings in year t
$M_t = M_{1t} + M_{2t}$ total savings in year t (only the active population saves)

If the tax ratio is τ,

$C_{1t} = (1-\tau) \times 3\frac{N_{1t}}{2} - M_{1t}$ consumption of youth in year t

$C_{2t} = (1-\tau) \times 3\frac{N_{2t}}{2} - M_{2t}$ consumption of the middle-aged in year t

Of which consumption of the elderly in year t
$C_{3t} = Y_t - C_{1t} - C_{2t} = Y_t - (1-\tau)\ Y_t + M_t = \tau Y_t + M_t$

In the model $\tau = 1/3$
és $M_{1t} = 0{,}01\ N_{1t}$ and youth savings in year t (a function of the number of youth)
$M_{2t} = 0{,}09\ N_{2t}$ middle-aged savings in year t (a function of the number of the middle-aged)

In the absence of inheritance

$M_{1t} = B_{1t,}$ or $M_{2t} = B_{2t}$ all savings are invested in bonds

B_{1t} bond holdings of youth in year t
B_{2t} bond holdings of the middle-aged in year t
$B_t = B_{1t} + B_{2t} = M_t$ total bond portfolio in year t is comprised of the savings of the active population

In case of inheritance (our example includes inheritance)

B_0 inherited bond portfolio
$B_t = B_0 + B_{1t} + B_{2t} = B_0 + M_t$ total bond portfolio in year t

in the model B_0=150 in every year
therefore, in this case

$M_t = B_t - B_0$ savings of the active population and inheritance

$s_t = \frac{M_t}{Y_t}$ savings rate in year t

$m_t = \frac{M_t}{M_{t-1}}$ growth rate of savings in year t

Fiscal correlations

$PE_t = N_{3t}$ primary expenditures in year t (old-age pension spending, a function of the number of the elderly)

$PI_t = \tau Y_t$ primary revenues in year t (a function of the tax ratio and the number of active individuals)

$Pb_t = PI_t - PE_t$ primary surplus

Other macroeconomic correlations

$M_t = -Pb_t$ fiscal overspending is equal to the savings of the (active) population

In case of a budgetary equilibrium

$PI_t = PE_t$

$N_{3t} = \tau Y_t$ old-age pension spending is equal to the pension contribution and

$$N_{3\tau} = \frac{N_{1\tau} + N_{2\tau}}{2}$$

If the population structure is constant (ratio of N_{1t}, N_{2t}, N_{3t}), the budget will remain in equilibrium. Demographic waves, however, have fiscal implications.

In case of a more rapidly ageing population

$N_{3\tau} > \frac{N_{1\tau} + N_{2\tau}}{2}$ the demographic shock upsets the budgetary equilibrium and

$C_{3t} = \tau_x Y_t + (B_t - B_0) = \tau_x Y_t + (M_{t1} + M_{t2}) = \tau_x Y_t - Pb_t$

The consumption of the elderly may be increased by the savings of the active population, i.e. the fiscal deficit above tax revenues. However, this also implies that the consumption of the active population together with the savings will fall short of their net income.
Income, in turn, will correspond to the sum of fiscal expenditures and the consumption expenditures of the active population.

$Y_t = C_{1t} + C_{2t} + C_{3t} = C_{1t} + C_{2t} + \tau_x Y_t - Pb_t = C_{1t} + C_{2t} + PE_t$

Underlying demographic factors of the debt path forecast

If the real interest is ***r***, the debt ratio in the 20th year will be

$$b_{20} = b_0[1+(r-g)]^{20} - \sum_{t=1}^{20} pb_t[1+(r-g)]^{t-1}$$ where r–g is granted.

$$b_t = \frac{B_t}{Y_t}$$ the debt ratio in year t

$$pb_t = \frac{Pb_t}{Y_t}$$ the primary balance as a percentage of GDP in year t

Notes

[1] Government debt should be distinguished from the debt accumulated by the private sector (companies, households and banks), as they are different in terms of macroeconomic role and impact. Public debt can be owed to domestic or foreign lenders and, accordingly, can be categorised as internal debt and external debt. A country's debt is generally comprised of the external debt of domestic stakeholders (the state and the private sector). Henceforth, our analysis will be limited to the debt accumulated by the state.

[2] "Either the nation must destroy public credit, or public credit will destroy the nation", Hume warned in 1742. He thought that the way out of public debt could be fairly destructive. The collapse could occur through "natural death" (the declaration of national bankruptcy) or "violent death", when the required expenditure cuts render the most important functions of the state (such as defence) impossible to execute, which may play the country into foreign hands (see also Inzelt, 2008). Nonetheless, England eventually managed to overcome its enormous debt burden without major repercussions.

[3] Source: UK National Debt Charts=www.ukpublicspending.co.uk

[4] Stock data pertain to the end of the year. Our simple model disregards segniorage and foreign exchange rate effects as well.

[5] We may recognise this correlation in a simpler, albeit slightly inaccurate, form: $d = by$ This simple correlation serves as a basis for the 3 per cent deficit requirement of the EU, which is calculated on the basis of an assumed 5 per cent nominal growth and the targeted 60 per cent debt ratio.

[6] In this case, the real interest rate is the risk-free rate charged on the debt. For a detailed interpretation of real interest, see Wigger, 2007

[7] Reference is made here to the golden rule of growth theory. In growth theory, consumption can be maximised alongside a growth path where the marginal product of capital equals the growth rate of the economy, i.e. r=g. This is called the golden age growth path.

[8] In this situation an increase in the saving rate may lead to an expansion of investment projects; however, this assumes a decline in current consumption. This is a prerequisite for future consumption growth. In such a scenario there is no room for a Pareto improvement.

9 When the economy accumulates too much capital, current investment projects – which also imply the foregoing of current consumption – exceed the future sacrifice, which is manifested in the moderation of future consumption. Therefore, it is not worth giving up current consumption, i.e. the current capital accumulation is not worth the sacrifice. The interest rate, which is lower than the economic growth rate, suggests that this is the situation we are currently experiencing (Abel, 1992, pp. 8–9).

10 In this case the saving rate declines. "Starting with too much capital relative to the level defined by the Golden Rule means that, in transition to the Golden Rule steady state, consumption is higher at all points in time than the initial level." (Mankiw, 2005, p. 128).

11 According to Mankiw – Elmendorf, while a Ponzi game leading to a Pareto improvement might be an interesting possibility, it has no practical relevance to the analysis of debt and growth developments in the USA and other economies. Indeed, most economists do not believe that excessive levels of savings would push interest rates below growth rate levels (Mankiw – Elmendorf, 1998).

12 In Hungary this is also known as a pilot scheme. For more detail, see: Minsky, 1992. While the Ponzi game, the pilot scheme and the pyramid scheme are often considered synonymous, there are slight differences between them.

13 According to the theorem known as Ricardian equivalence, the current generation saves the proceedings from the overspending of the government on the assumption that the state intends to increase its future tax revenues to finance public debt. Therefore, it is not possible to pressure private individuals to spend more by increasing public expenditures.

14 In the original approach, even the first case is a Ponzi game, since the principal is not paid back (ever).

15 In this instance r indicates the risk-free interest rate charged on public debt.

16 In this case the overspending of the state crowds out the dynamically inefficient economy's overaccumulation of capital, rather than the capital accumulation of the private sector (Blanchard – Weil, 2002). Pareto suboptimality is a sufficient condition for the feasibility of Ponzi games. Indeed, given the imperfections of the market, uncertainty, asymmetric information and the existence of transaction fees open up the possibility for Ponzi games and the state's debt financing.

17 In this context, r indicates the long-term interest rate on government securities.

18 It should be noted that in this particular analysis MEB presented, as early as 1995, precisely the same developments that were observed in the wake of the current crisis, i.e. the role of low-probability developments with significant implications (fat tail problem).

19 The overwhelming majority of analyses and research are conducted in the USA and they mainly respond to problems arising in the North American economy. Other countries tend to adopt the same models, albeit with different levels of revision Nevertheless, these versions may inadvertently retain certain assumptions that apply only to specific countries in special situations. We teach from American books citing American references.

20 Foreign currency lending had the same effect in the CEE region: by artificially pushing down interest rates, it changed the relationship between the interest rate level *(r)* and income generation (disposable income) even within the private sector. For a while, the process concealed the real burdens of indebtedness.

21 As regards open economies, this process takes place slightly differently. The domestic interest

rate level does not rise necessarily, since the inflow of foreign capital exerts downward pressure on interest rates. Against this background, however, foreign debt increases parallel to domestic indebtedness.

22 In a simplified form this corresponds to $i–y$ and $r–g$, and in this study we generally refer to it as such henceforth.

23 In certain peripheral EMU Member States (Spain, Greece and Ireland) the normality rule did not hold true. In addition, our own calculations indicate that, over the past decade, the golden rule on debt did not prevail in Hungary either.

24 This is the general assumption of macroeconomic models. With this they deny the operation of the Ponzi game at the outset. Consequently, the analysis of bubbles, which have the same roots as the Ponzi game, was relegated to the background (see Obstfeld – Rogoff, 1996).

25 See for example Abel, 1992, p. 7.

26 It is important to realise that this is a very interesting situation. Based on the explanations discussed above, this Ponzi game is a theoretical impossibility. In point of fact, however, this is the really "visible" Ponzi. The debt ratio is clearly on the rise, making it obvious that Ponzi financing is at work; in other words, loans are used to finance debt service (together with a part of current expenditures). Interest on the debt and the principal are paid from new credit.

27 "Despite the scientific paradigm shift of the 1970s, the role of the state did not diminish; in fact, its weight increased spectacularly relative to its already very high levels". Muraközy, 2010, p. 784.

28 See also Szabó, 1998, Simonovits, 2002.

29 The 'target rate' portfolios used by insurance companies and pension funds determine the portfolio structure on the basis of age.

30 In the USA, for example, at the peak of the baby boom the number of births exceeded the births recorded for the previous and the subsequent periods by 40 and 50 per cent, respectively. Our own assumption implies a fluctuation of 20–25 per cent, which does not appear to be extreme even by historical standards.

31 Since our model is limited to two actors – citizens and the state – it does not include corporations and non-residents.

32 For the sake of simplicity, in our initial OLG model we assumed that the contribution amounted to 33 per cent.

33 See also IMF, 2010.

34 This assumption may sound strange, considering the unprecedented low level of the long-term yields seen in developed markets. We should keep in mind, however, that this is stemming from an unprecedented loose monetary policy, which generates nominal revenues and savings for government securities. As soon as the monetary loosening is over, yields will suddenly rebound, and the process will be bolstered by the demographic shock as well.

35 For more details on the scope of the indispensable adjustments, see IMF, May 2010.

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